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Savings through energy efficiency

What is Mass Save®?

Mass Save® is an initiative sponsored by Massachusetts' gas and electric utilities and energy efficiency service providers, including **Columbia Gas of Massachusetts, The Berkshire Gas Company, Cape Light Compact, National Grid, Liberty Utilities, NSTAR, Unitil, and Western Massachusetts Electric Company**. The Sponsors of Mass Save work closely with the Massachusetts Department of Energy Resources to provide a wide range of services, incentives, trainings, and information promoting energy efficiency that help residents and businesses manage energy use and related costs.

Codes and Standards (C&S) as part of Energy Efficiency Programs

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Residential and Commercial Offers

Residential New Construction

- **Low-Rise New Construction**
  - Performance Path – based upon a % improvement over the MA baseline – incentives up to $7,000
  - Prescriptive Path – incentives up to $7,000 for measures beyond MA baseline
- **High-Rise New Construction**
  - Incentives based upon actual measures

Commercial New Construction

- **Incentives for efficiency levels beyond code:**
  - **Whole building incentives**
  - **System incentives including**
    - Air Compressors
    - Chillers
    - Lighting and Lighting Controls
    - Gas-Fired Heating Equipment
    - Variable Speed Drives
    - Custom Measures
    - And more

We also offer incentives and rebates for existing buildings as well. Please visit www.MassSave.com for the details.

The Residential Energy Code
2009 IECC to 2012 IECC

September 29, 2014

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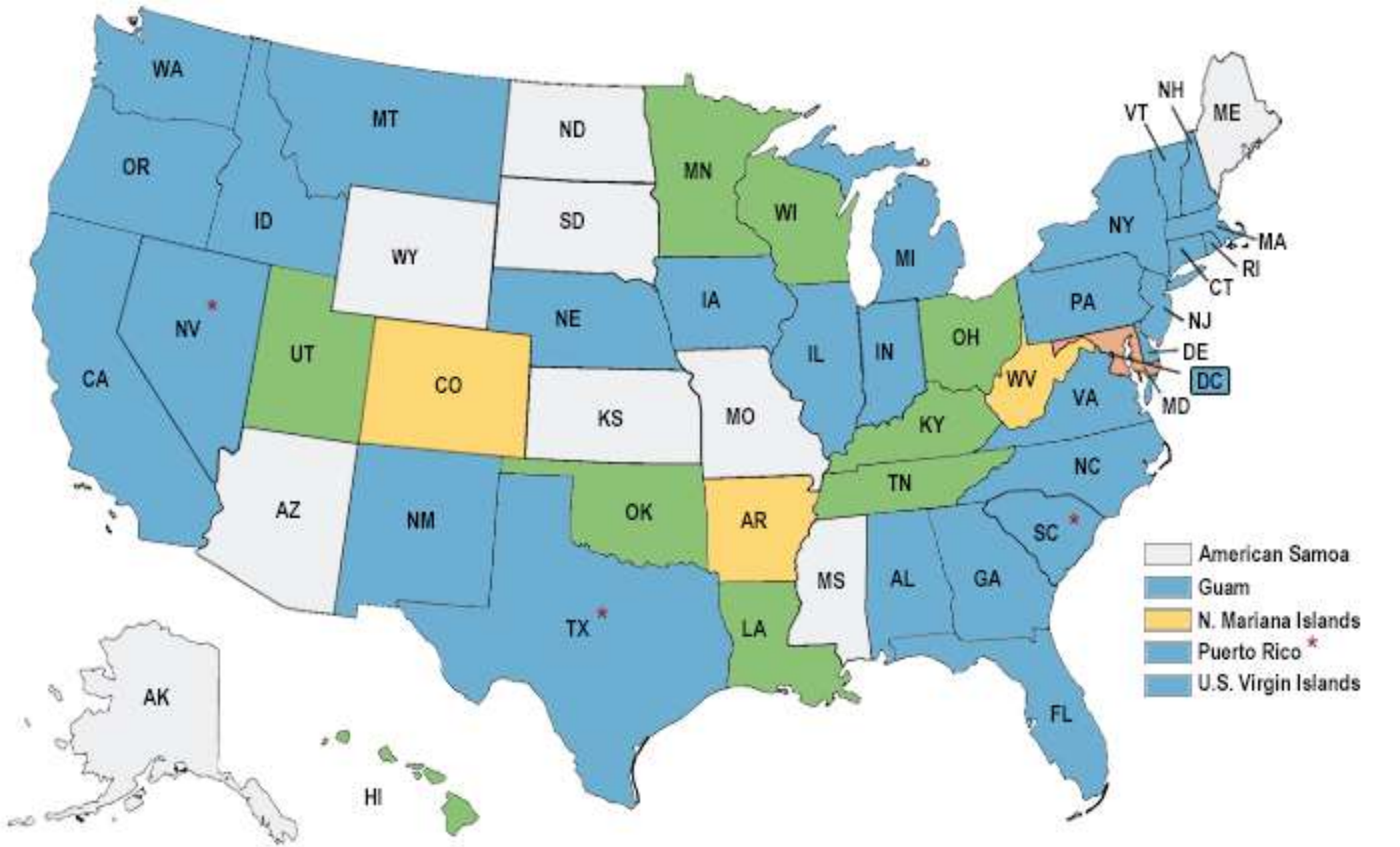
Conservation Services Group

Learning Objectives

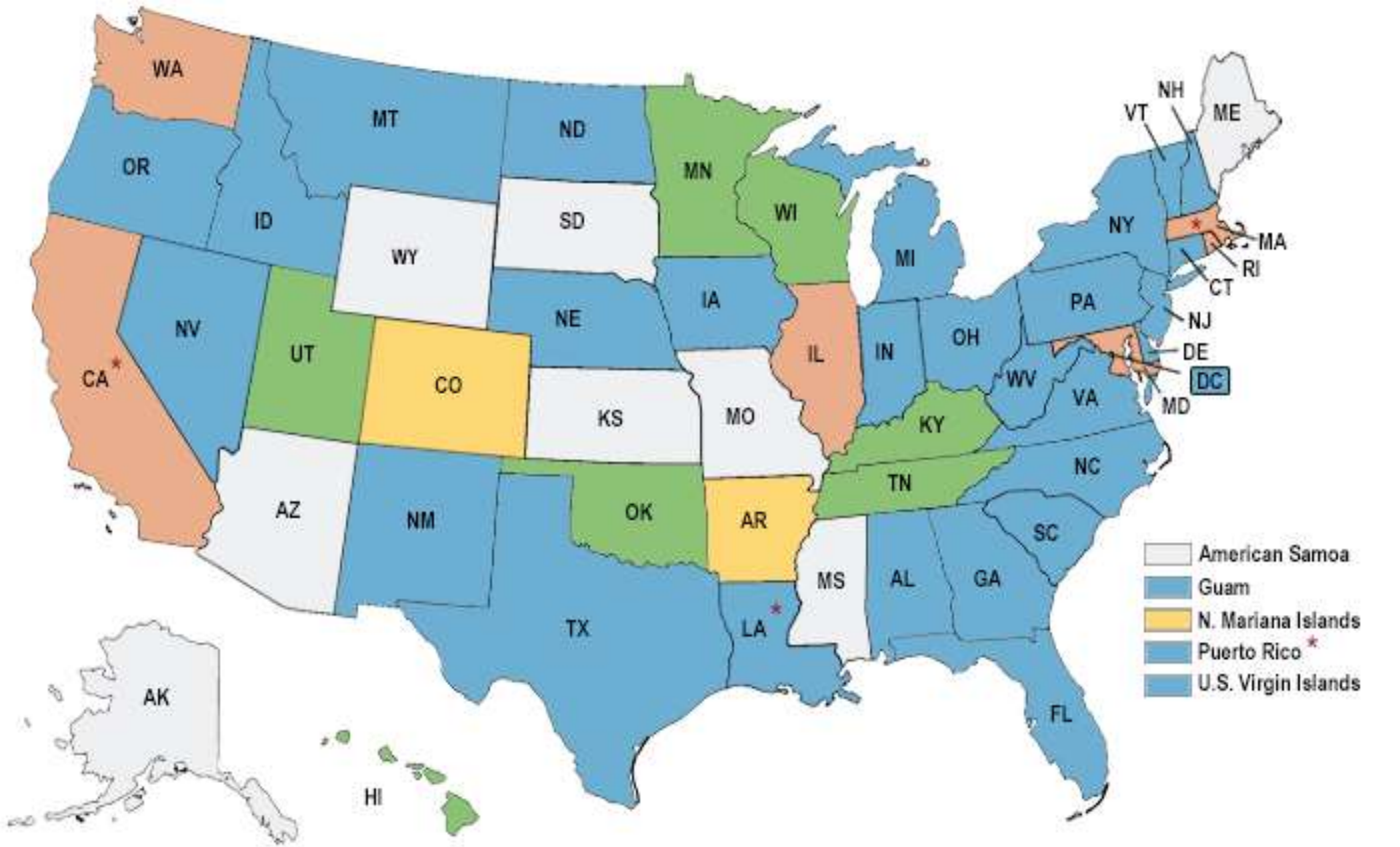
1. Compare 2009 and 2012 IECC
2. Discuss ways to achieve compliance with the new energy code
3. Evaluate mechanical ventilation options
4. Examine the Performance Path requirements

Agenda

- 2012 IECC background
- Applicability and Exceptions
- Prescriptive insulation requirements
- Mandatory air barrier insulation installation highlights
- Mandatory air leakage performance test
- Mechanical ventilation
- MA Amendments



* Adopted new Code to be effective at a later date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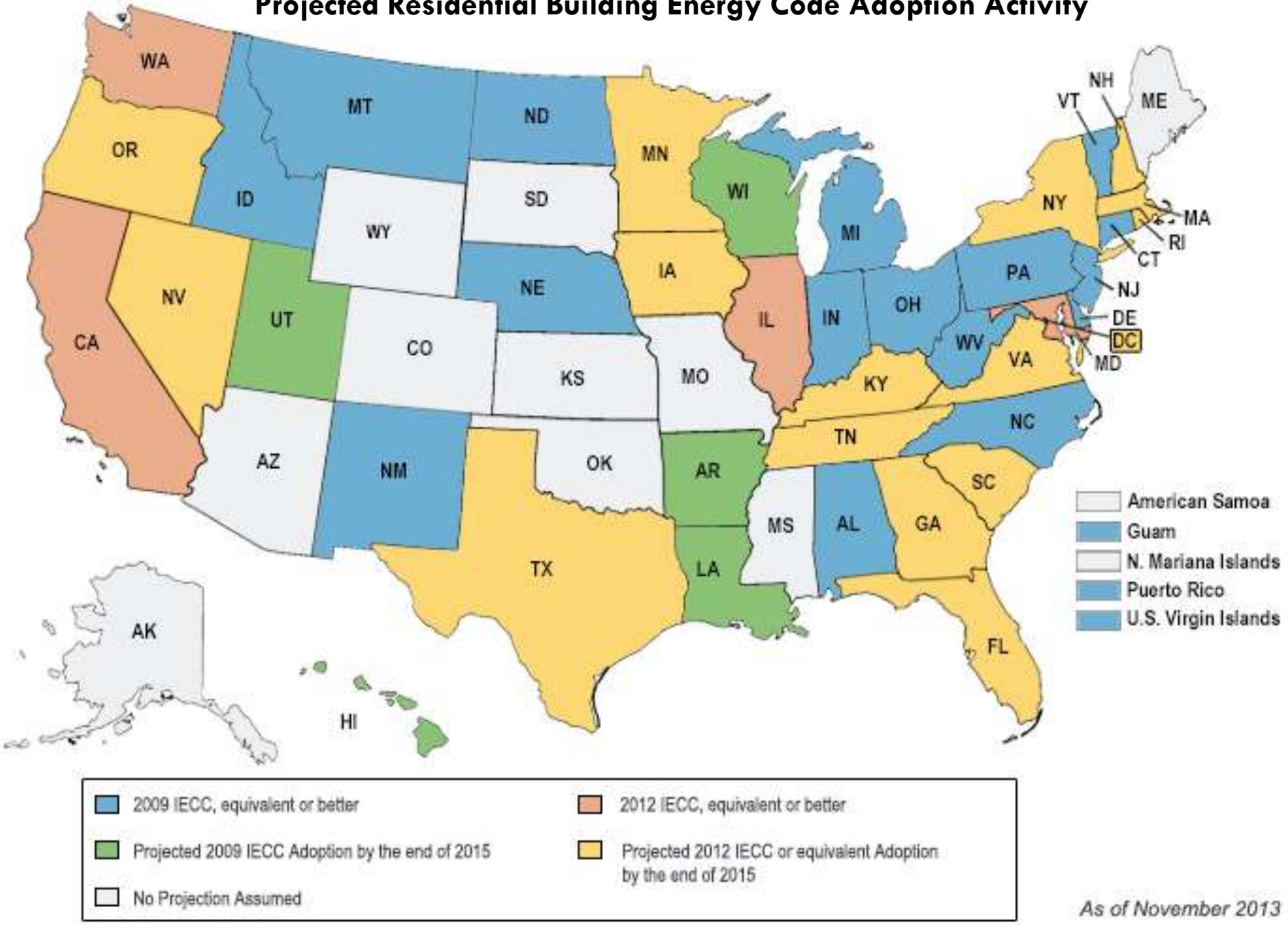
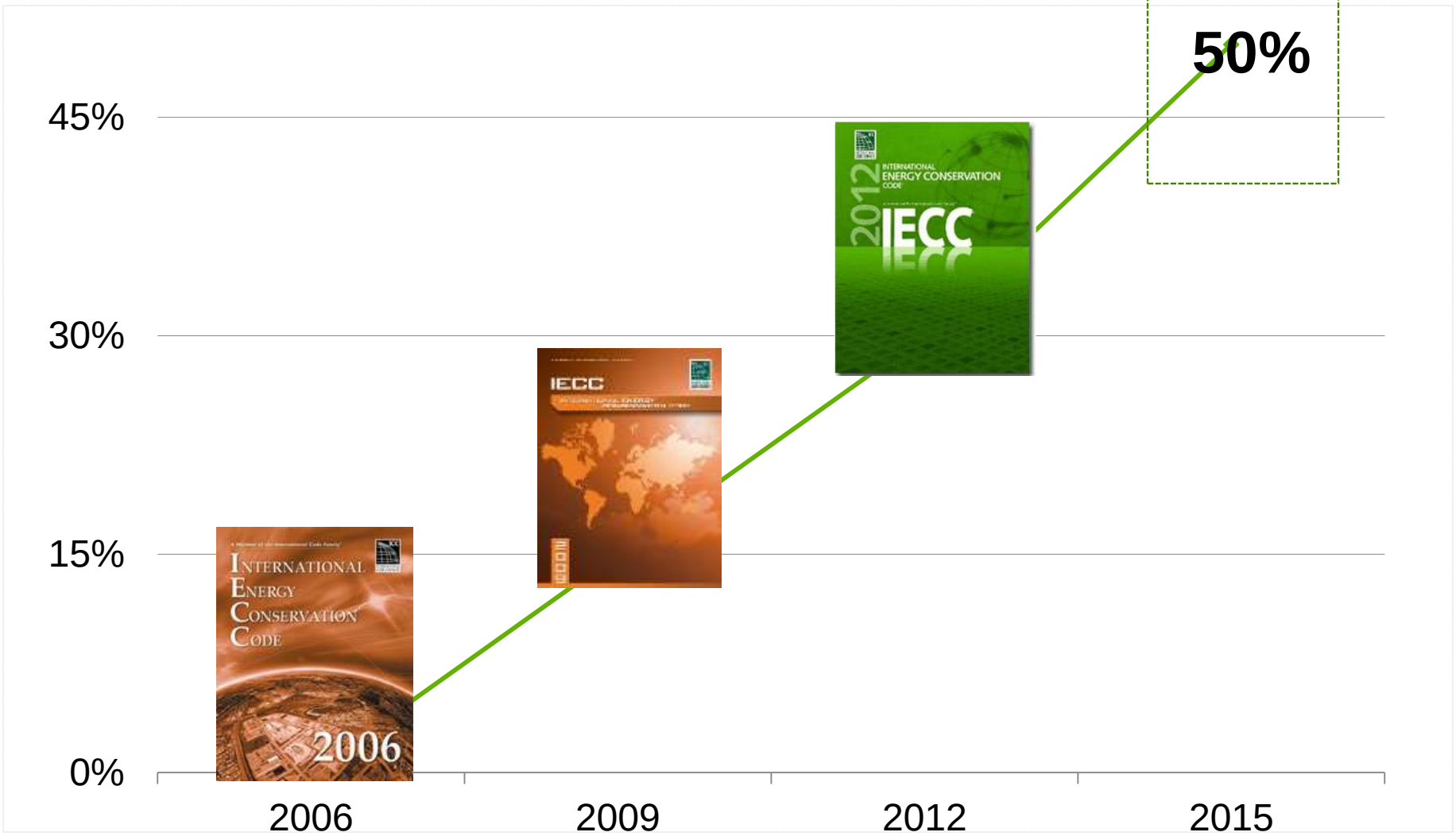
American Samoa
Guam
N. Mariana Islands
Puerto Rico *
U.S. Virgin Islands
6 IECC 2012, equivalent or more energy efficient
30 IECC 2009, equivalent or more energy efficient
8 IECC 2006, equivalent or more energy efficient
3 IECC 2003, equivalent or less energy efficientt
9 No Statewide Code
* Adopted new Code to be effective at a later date
As of November 2013

Projected Residential Building Energy Code Adoption Activity



As of November 2013

Energy Savings



Chapter 1

Scope and Administration

Part 1 – Scope & Application

This code applies to residential buildings, **the building sites, and associated systems*

*Note - new content & MA Amendments in green

R101.4 – Existing Buildings

- Except as specified in this chapter, this code shall not be used to require the removal, alteration or abandonment… of an existing building or building system

- *Renovations & Repairs* to an existing building.. .. *shall conform* to this code *as they relate to* ***new construction***

R101.4 – Applicability: Exemptions

- Low energy buildings
  - Less than 1 watt or 3.4 BTU/h per sq. ft. of floor area
- Unconditioned buildings
- Historic buildings/structures
  - Listed on State or National Register
  - Designated as historic under local or state designation

R101.4.3 – Exceptions

- *Storm windows* over existing fenestration
- *Glass replacement* in existing sash and frame
- Existing ceiling, wall, or floor cavities exposed during construction provided that these cavities are *filled with insulation*

R101.4.3 – Exceptions

- Where existing roof, wall, or floor *cavity* is *not exposed*
- Reroofing where *neither sheathing nor insulation is exposed*

R102.1.1 – Above Code Programs

- Code official *shall be permitted to deem* a national, state or local energy efficiency program to exceed the energy efficiency required by this code
- Buildings *approved in writing* by such programs shall be considered in compliance
- *Mandatory requirements shall be met*

Chapter 3

General Requirements

R303.1.1.1
Blown or Sprayed Roof/Ceiling Insulation

Depth displayed: Blown/sprayed insulation (cellulose or fiberglass) –

Markers shall be installed 1/300SF, facing access

Installer Certification

Chapter 4

Prescriptive

R401.2 – Compliance

- Projects *shall* comply with
  - Mandatory Sections *and*

    either

  - Prescriptive

    or

  - Performance Sections

R402 – General Insulation Requirements (Prescriptive)

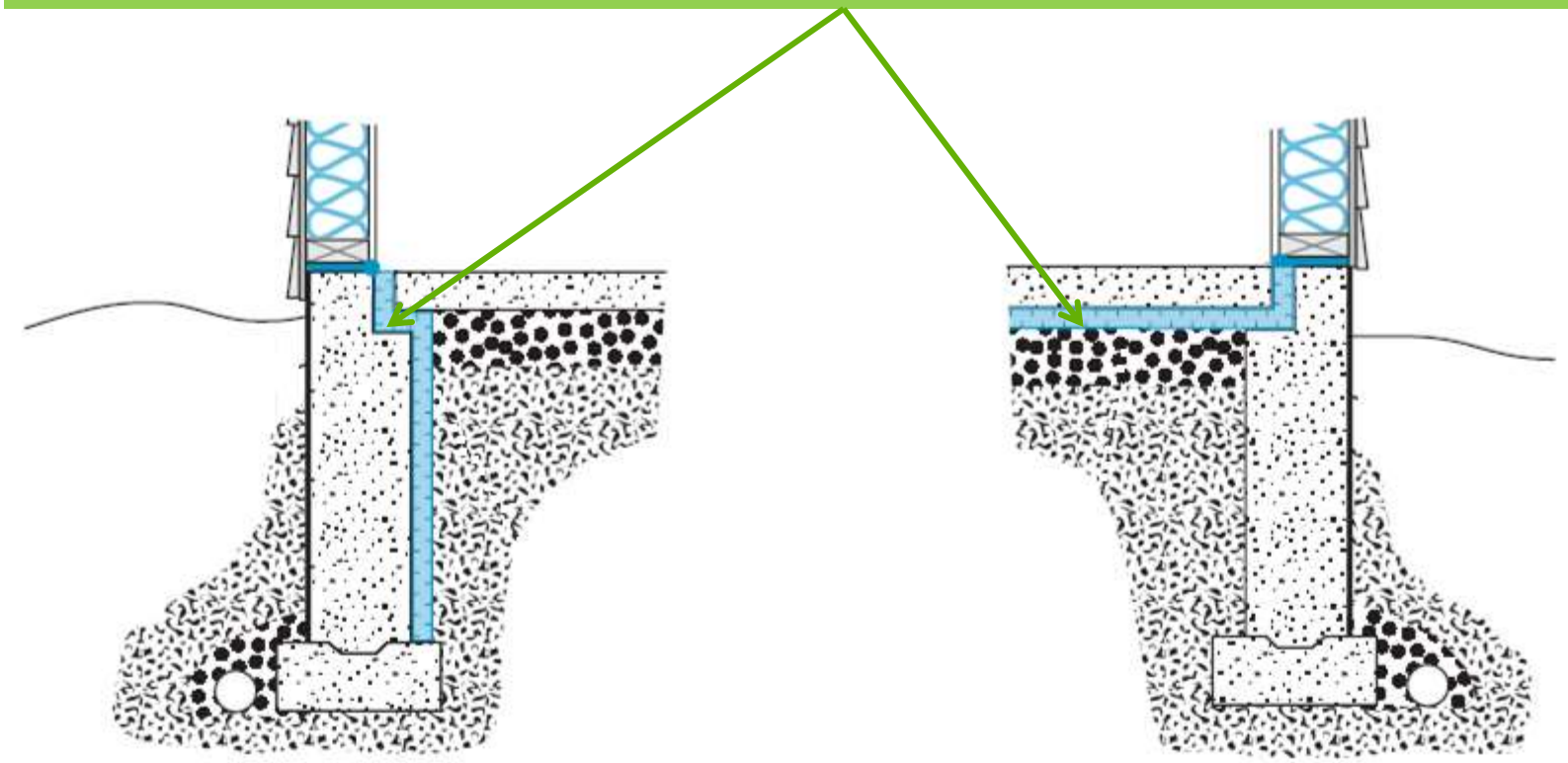
- Thermal envelope shall meet either:
  - Table R402.1.1 - R-value computation:
    - Cavity plus insulating sheathing
    - Settled R-value – blown materials
    - But NOT other material or air films
  - Table R402.1.3 – Assembly U-factors
  - R402.1.4 – Total UA alternative
    - Sum of U factors multiplied by the assembly area

R402.1.1– Prescriptive Requirements - Zone 5

Component	2009	2012
Windows	U-0.35	**U-0.32**
Skylight	U-0.60	**U-0.55**
Ceiling	R-38	**R-49**
Frame Wall	R-20 *or* R-13 + 5	R-20 *or* R-13 + 5
Mass Wall	13/ 17 (Ext/Int)	13/17 (Ext/Int)*
Floor	30	30
Basement/crawlspace Wall	R-10/R-13	**R-15/19**
Slab R-Value & Depth	R-10, 2 ft.	R-10, 2 ft.

Slab Edge Interior Insulation

R-10 for 2’ - horizontal/vertical/combination)



R-15 for heated slabs

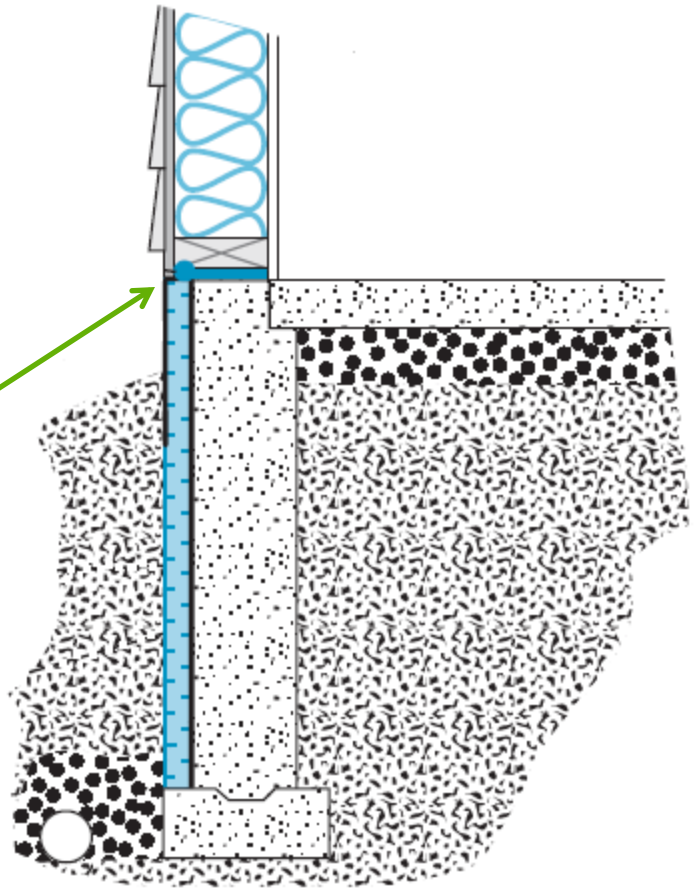
Slab on Grade

Insulation under entire slab with beveled perimeter

Photo © Conservation Services Group

Slab edge exterior insulation

2’ of R-10



Protect insulation,
Install termite shield

R402 – Specific Insulation Requirements (Prescriptive)

- Ceilings: R-38 for R-49 if full height over top plate
- Ceiling w/out attic spaces
  - R-30 allowed for 500 SF or 20%, whichever is less
- **Eave baffles**
- Access hatches & doors
  - Sealed, weather-stripped, insulation = surrounding area
  - Retainer required with loose fill
- Floors: insulation in permanent contact with deck above

R402.2.3 – Eave Baffle (Prescriptive)

For air permeable insulation in vented attics, a baffle (any solid material) shall be installed, shall maintain an opening greater than or equal to the size of the vent, shall extend over top of insulation

Chapter 4

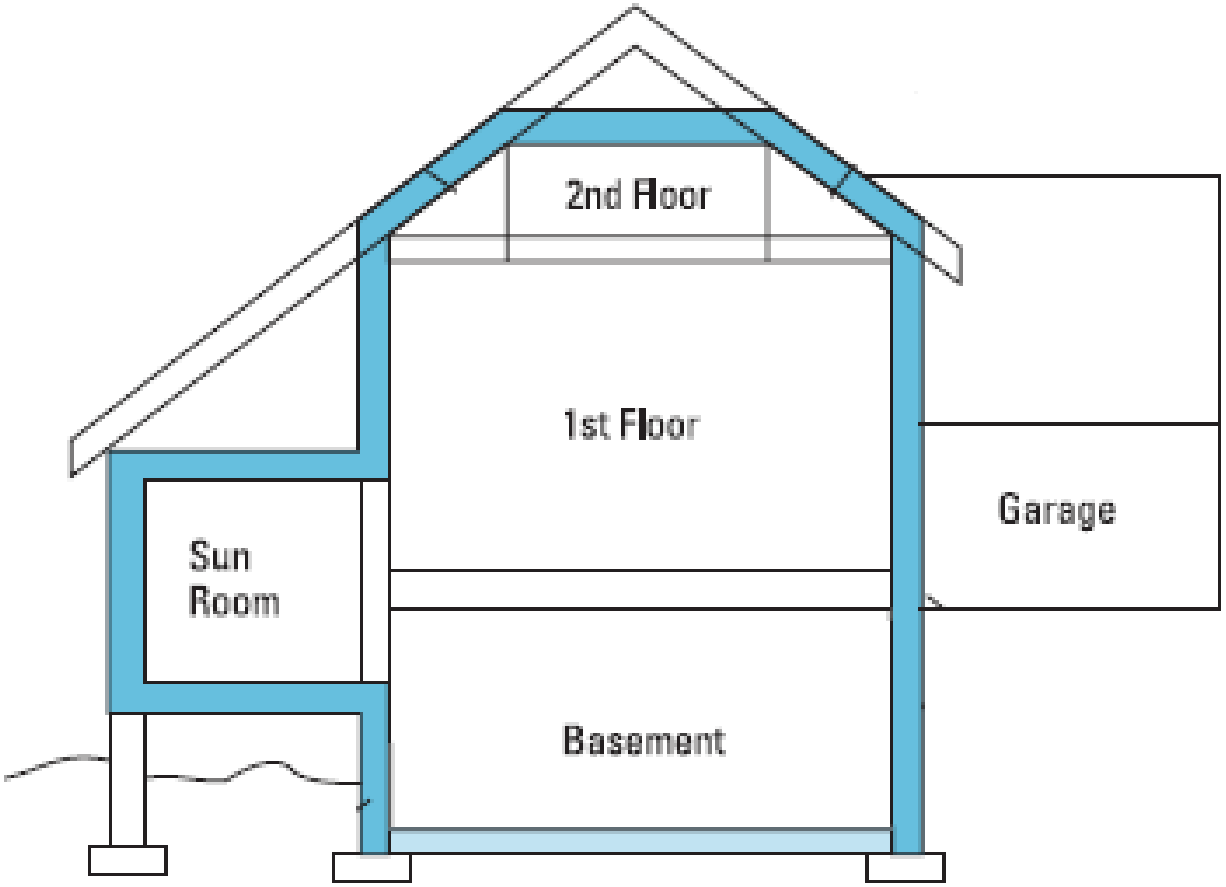
Air Leakage – Checklist

Mandatory

R402.4.1 thru R402.4.4 – Air Leakage (Mandatory)

2009	2012
Table 402.4.2	Table R402.4.1.1
OR	*AND*
7.0 ACH50	3.0 ACH50

Define the Air & Thermal Boundary



R402.4.1.1 – Air Barrier and Thermal Barrier (Mandatory)

- A continuous air barrier shall be installed in the building envelope
- Exterior thermal envelope contains a continuous air barrier

Photo © Tremco Inc.

Photo © Conservation Services Group

R402.4.1.1 – Air & Thermal Barrier (Mandatory)

Breaks/joints in air barrier shall be sealed

Photo © Conservation Services Group

R402.4.1.1 – Air & Thermal Barrier (Mandatory)

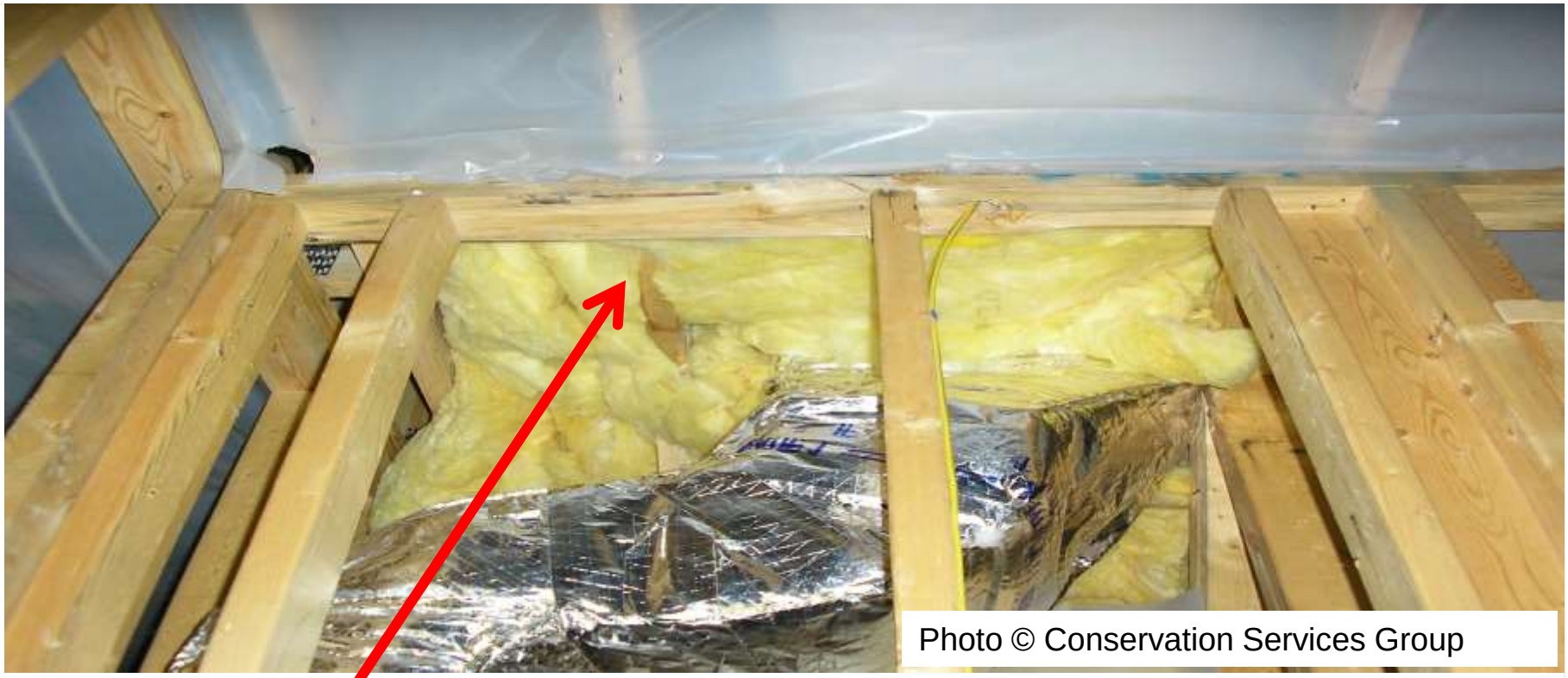


Photo © Conservation Services Group

Air permeable insulation shall not be used as a sealing material

R402.4.1.1 – Ceiling/Attic (Mandatory)

Air barrier in dropped ceiling/soffit aligned with insulation and gaps sealed

R402.4.1.1 – Ceiling/Attic (Mandatory)

Access openings shall be sealed

Photo © Conservation Services Group

R402.4.1.1 – Walls (Mandatory)

Corners and headers are insulated

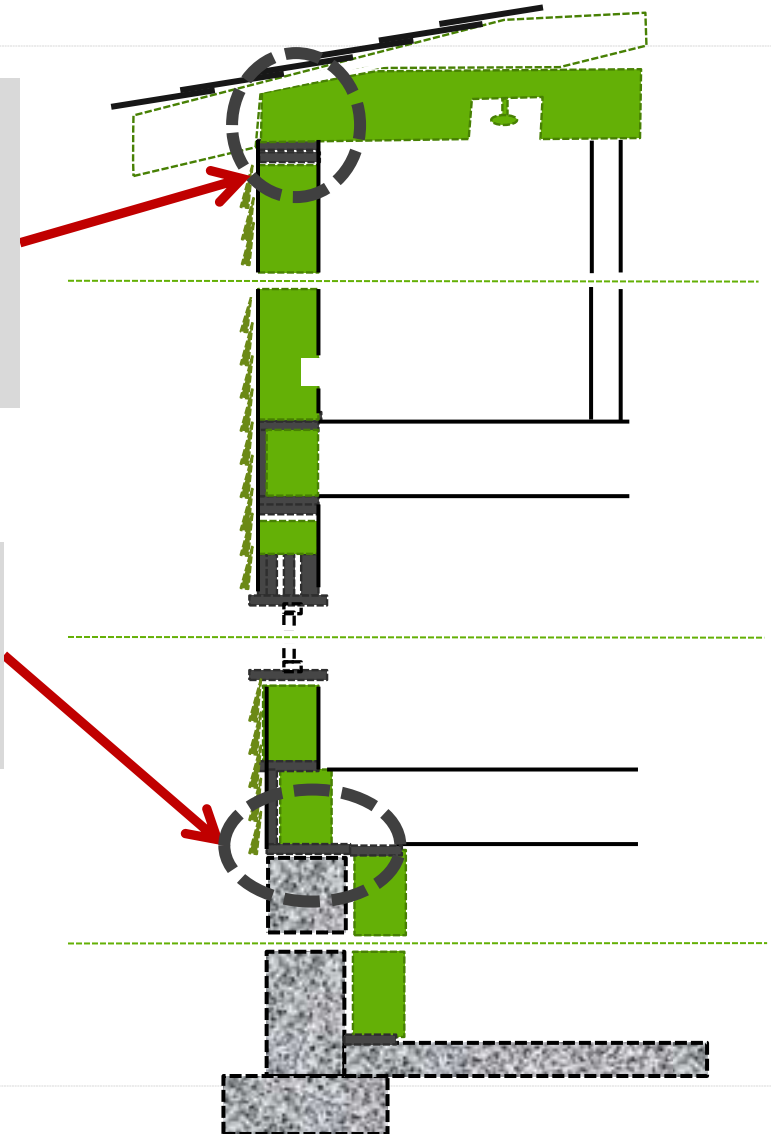
Photo © Conservation Services Group

Photo © Conservation Services Group

R402.4.1.1 – Walls (Mandatory)

The junction of the top plate and top of exterior walls shall be sealed

Junction of foundation and sill plate is sealed

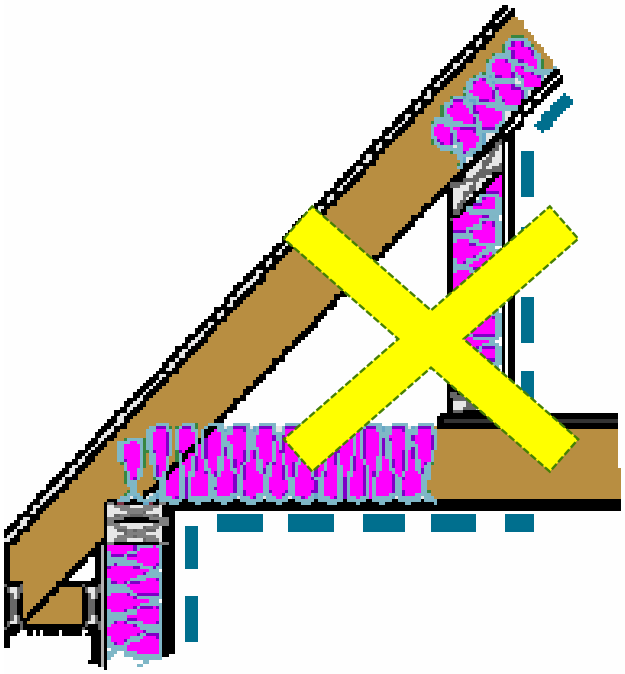


R402.4.1.1 – Walls (Mandatory)

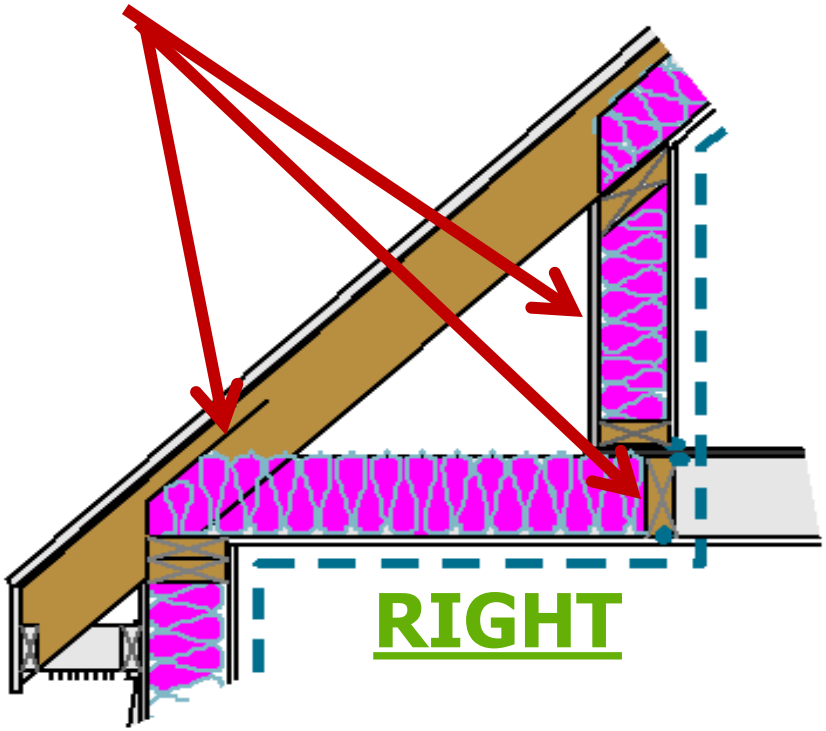
Insulation shall be installed in substantial contact and continuous alignment with the air barrier

R402.4.1.1 – Walls (Mandatory)

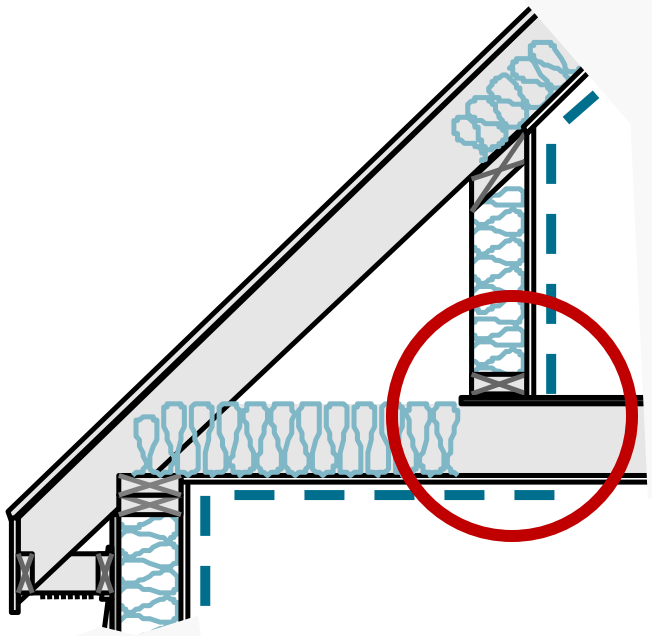
Knee walls shall be sealed

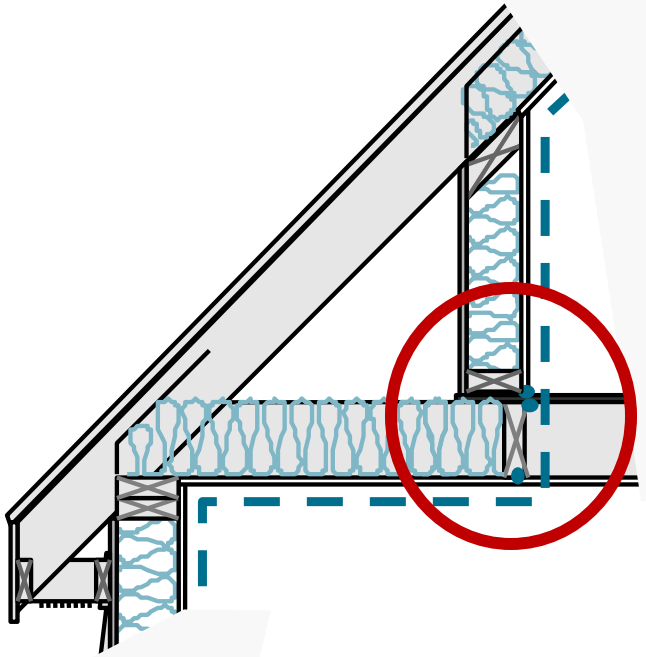


WRONG



RIGHT





Photos © Conservation Services Group

R402.4.1.1 – Windows, Skylights & Doors (Mandatory)

Space between windows/skylights/ door jambs *and* framing shall be sealed

Photo © Conservation Services Group

R402.4.1.1 – Rim Joists (Mandatory)

Photo © Conservation Services Group

Photo © Conservation Services Group

Insulate and include air barrier

R402.4.1.1 – Floors (Mandatory)

Insulation is installed to maintain permanent contact with underside of subfloor decking

Photo © Conservation Services Group

Photo © Conservation Services Group

R402.4.1.1 – Floors (Mandatory)

Photo © Conservation Services Group

Air Barrier installed at any exposed edge of insulation

R402.4.1.1 – Crawlspace Walls (Mandatory)

Insulation *permanently* attached

Photo © Conservation Services Group

R402.4.1.1 – Shafts/Penetrations: Sealed (Mandatory)


Photo © Conservation Services Group

- Duct shafts
- Utility penetrations
- Knee walls
- Flue shafts opening to exterior/ unconditioned space

Why Air/Thermal Boundaries Matter?

Photo © J Kelly

R402.4.1.1 – Narrow Cavities (Mandatory)

Batts -

- Cut to fit

  or

- Spray/blow insulation

Photo © Conservation Services Group

R402.4.1.1 – Garage Separation (Mandatory)

Air sealing is provided *between the garage and conditioned spaces*

R402.4.4 – Recessed Lighting Fixtures (Mandatory)

- Installed in thermal envelope - *shall be IC rated* and *air tight*
  - ASTM E 283: No more than 2.0 CFM air movement
- Housing *sealed or gasketed to finish*

Photo © Conservation Services Group

R402.4.1.1 – Plumbing & Wiring (Mandatory)

Photo © Conservation Services Group

Insulation between, around, in front and behind

R402.4.1.1 – Showers and Tubs (Mandatory)

Photo © Conservation Services Group

R402.4.1.1 – Electric Boxes (Mandatory)

Air barrier goes behind boxes *or* install air tight boxes

Photo © Conservation Services Group

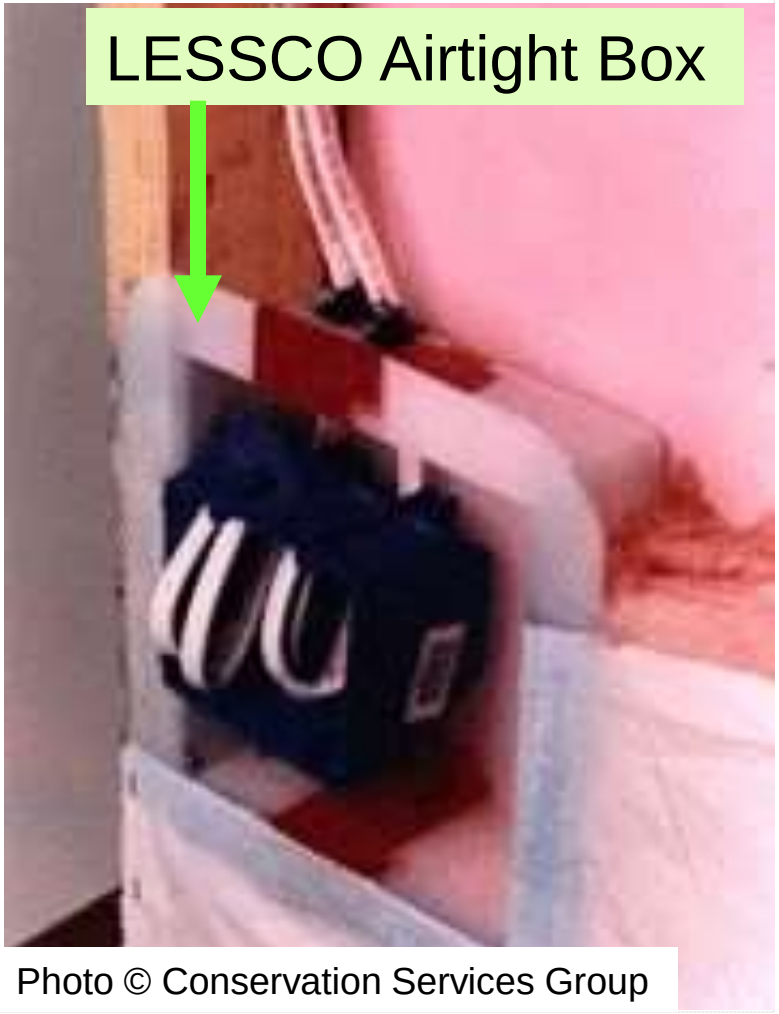


Photo © Conservation Services Group

R402.4.1.1 – HVAC Register Boots (Mandatory)

Sealed to subfloor or drywall

Photo © Conservation Services Group

R402.4.1.1 – Fireplaces (Mandatory)

Photo © Conservation Services Group

Fireplace walls include an air barrier

R402.4.1.1 – Fireplaces (Mandatory)

New wood burning fireplaces shall have *gasketed doors

Photo © Conservation Services Group

*new to checklist

R402.4.2 – Fireplaces (Mandatory)

New wood burning fireplaces shall have tight-fitting flue dampers and outdoor combustion air

Chapter 4

Air Leakage – Standards & Testing

R402.4 – Air Leakage (Mandatory)

2009	2012
Table 402.4.2	Table R402.4.1.1
OR	*AND*
7.0 ACH50	3.0 ACH50

Benchmarks

- IECC 2009 – **7** ACH50 (Performance)
- MA New Construction Program through 2006 – **5** ACH50
- Canadian R-2000 – **1.5** ACH50
- Passive House – **0.6** ACH50
- IECC 2012 – **3** ACH50

Air Changes/Hour @ 50 Pa (ACH50)

- Describes flow in relation to volume
- Number of times per hour air equal to volume of building moves in/out

What is ACH50?

$$ACH50 = \frac{CFM50 \times 60}{Volume}$$

Information needed:

CFM @ 50 Pascals = 1,420 CFM

plus…

Volume of the home

What is the ACH50?

$$ACH50 = \frac{CFM50 \times 60}{Volume}$$

$$Volume = 1{,}536 \times 8 = 12{,}288\ cu.\ ft$$

$$ACH50 = \frac{1{,}420\ cfm \times 60}{12{,}288\ cu.\ ft} = 6.93\ ACH50$$

Code Compliant?

614 *cfm*

$$ACH50 = \frac{\cancel{1{,}420}\ cfm \times 60}{12{,}288\ cu.ft} = \cancel{6.93}\ ACH50$$

3.0

MA Amendment

Air Leakage Testing & Verification

R402.4.1.2 - Air Leakage Testing

- Testing and verification shall be done by one of the following:
  - HERS Rater
  - HERS Rating Field Inspector
  - BPI Certified Professional
  - BBRS *approved* Third party
- Using RESNET approved equipment

Chapter 4

Systems

R403.2.2 – Duct Sealing (Mandatory)

Photo © Conservation Services Group

- Ducts, air handlers, and filter boxes shall be sealed
- Joints and seams shall comply with IMC or IRC
  - UL ratings for sealants
  - Fastenings

R403.2.2 – Duct Testing (Mandatory)

		2009	**2012**
Post-Construction	**Total Leakage**	12	**4**
	Leakage to Outside	8	**n/a**
Rough-in	**Total Leakage**	6	**4**
	Total Leakage w/out air handler	4	**3**

R403.2.2 – Duct Testing (Mandatory)

No duct testing required if all ducts are within conditioned space

Duct sealing is always required

R403.2.2 - Duct Leakage Testing - MA

- Post construction or rough-in testing and verification shall be done by one of the following:
  - HERS Rater
  - HERS Rating Field Inspector
  - BPI Certified Professional
  - BBRS *approved* Third party
- Following approved testing standards

Benefits of Duct Sealing

- Improved comfort
  - Increases delivery of conditioned air
- Improved indoor air quality
  - Reduces distribution of pollutants; dirt, dust, mold, fumes from solvents, radon gas, and CO
- Better humidity control
  - Recirculates conditioned air over evaporator coil
- Lower energy use

Get Ducts out of Unconditioned Spaces!

Photo © Conservation Services Group

Why Bring Ducts Inside?

- Eliminate need to insulate / test ducts
- Reduce callbacks
- Ensure load calculation works
  - Do not lose capacity

R403.2.2.1 – Sealed Air Handler (Mandatory)

Air handler leakage rate no more than 2% of design flow rate

Photo © Conservation Services Group

R403.2.2.3 – Ducts (Mandatory)

Building cavities shall not be used as ducts or plenums

Photo © Conservation Services Group

Pipe Insulation (Mandatory)

- Below 55°
- Above 105°
  - R-3 required

Photo © Conservation Services Group

- Insulation exposed to the weather shall be protected from damage
- Adhesive tape not permitted

R403.4.2 – DHW Pipe Insulation

- Mandatory: Circulating hot water systems shall have *automatic* or *readily accessible switch* to turn off when not in use

- Prescriptive: R-3 pipe insulation required except for very short runs (indexed to pipe diameter)

R403.6 – Equipment Sizing (Mandatory)

Heating and cooling equipment shall be *sized according to ACCA Manual S based on building loads calculated with ACCA Manual J* or other approved heating and cooling calculation methodologies

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MA Amendment - Combustion Appliances

R403.5.7 -Combustion Appliances

- Combustion & Solid Fuel Burning Appliances
  - Furnaces, boilers, DHW appliances shall be:
    - Mechanically vented
    - Direct vented
    - Power vented/exhausted
  - Exception:
    - Meet RESNET/BPI combustion safety test and limits for depressurization, spillage, draft pressure, and CO concentration in ambient air

Ventilation *is* a Life Safety Issue

R403.5 – Mechanical Ventilation (Mandatory)

- IECC - meet IRC or IMC

IMC says ventilate if ≤ 0.35ACHn

and

IECC - Building must be ≤ 3 ACH50

therefore

Under 2012 IECC, ventilation always required

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MA Amendment - Ventilation

R403.5 Mechanical Ventilation (Mandatory)

Each dwelling unit shall be provided with:

- Continual Exhaust *or*
- Balanced mechanical ventilation
- Site verified to meet minimum air flow per…

R403.5 Mechanical Ventilation Options (Mandatory)

1. Energy Star Homes Version 3 *or*
2. ASHRAE 62.2 – 2013 *or*
3. The following formula:
   - CFM = 0.03 x CFA + 7.5 x (Nbr+1) - .052 x CFM50 x height ratio x location factor

Option 1 - Formula
ENERGY STAR Homes V3

ENERGY STAR Homes V3 provides two options, ASHRAE 2010 formula or table:

- Ventilation Formula
  - CFM = 0.01 x floor area + 7.5 x (Nbr +1)
- Table

Option 1 – Table
ENERGY STAR Homes V3

3 Bedroom - 2,500 square feet

Floor Area (ft^2)	Number of Bedrooms				
	0 - 1	2 - 3	4 - 5	6 - 7	7+
< 1,500	30	45	60	75	90
1,501 - 3,000	45	60	75	90	105
3,001 - 4,500	60	75	90	105	120
4,501 - 6,000	75	90	105	120	135
6,001 - 7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

Option 2 - Formula
ASHRAE 62.2 – **2013**

- ASHRAE 62.2 – ventilation standard for low rise residential

- CFM = 0.03 x floor area + 7.5 x (N_{br} +1)

Option 1 – Table
ASHRAE 62.2 **2013**

3 Bedroom - 2,500 square feet

Floor Area (ft^2)	Number of Bedrooms				
	0 - 1	**2**	**3**	**4**	**5**
< 500	30	38	45	53	60
501 - 1,000	45	53	60	68	75
1,001 - 1,500	60	68	75	83	90
1,501 - 2,000	75	83	90	98	105
2,001 - 2,500	90	98	105	113	120
2501 - 3,000	105	113	120	128	135

Option 3 - Formula

CFM =

0.03 x CFA + 7.5x (Nbr+1) -.052 x CFM50 x height ratio x location factor

ASHRAE 62.2 - 2013 with infiltration credit

R403.5 Options Comparison

2500 Sq.Ft. Home – 3 Bedrooms		
Option	**Compliance Metric**	**CFM**
1a	E* STAR V3 ASHRAE 62.2-**2010** formula	55
1b	E* STAR V3 ASHRAE 62.2-**2010** table	60
2a	ASHRAE 62.2 **2013** formula	105
2b	ASHRAE 62.2 **2013** table	105
3	MA Calculation ASHRAE 2013*	85

R403.5.2 – Ventilation System Testing

Installed performance of the system shall be measured by one of the following:

- HERS Rater
- HERS Rating Field Inspector
- BPI Certified Professional
- BBRS *approved* Third party

- Using RESNET, ACCA or BBRS approved equipment

R403.5 Mechanical Ventilation (Mandatory)

Ventilation Equipment must be certified by:

- HVI (Home Ventilating Institute) *or*
- AMCA (Air Movement and Control Association)

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MA Amendment – Sound

R403.5.4 Sound Rating (Mandatory)

- One sone or less
- Exception – remote fans (4 ft)

R403.5.5 Documentation (Mandatory)

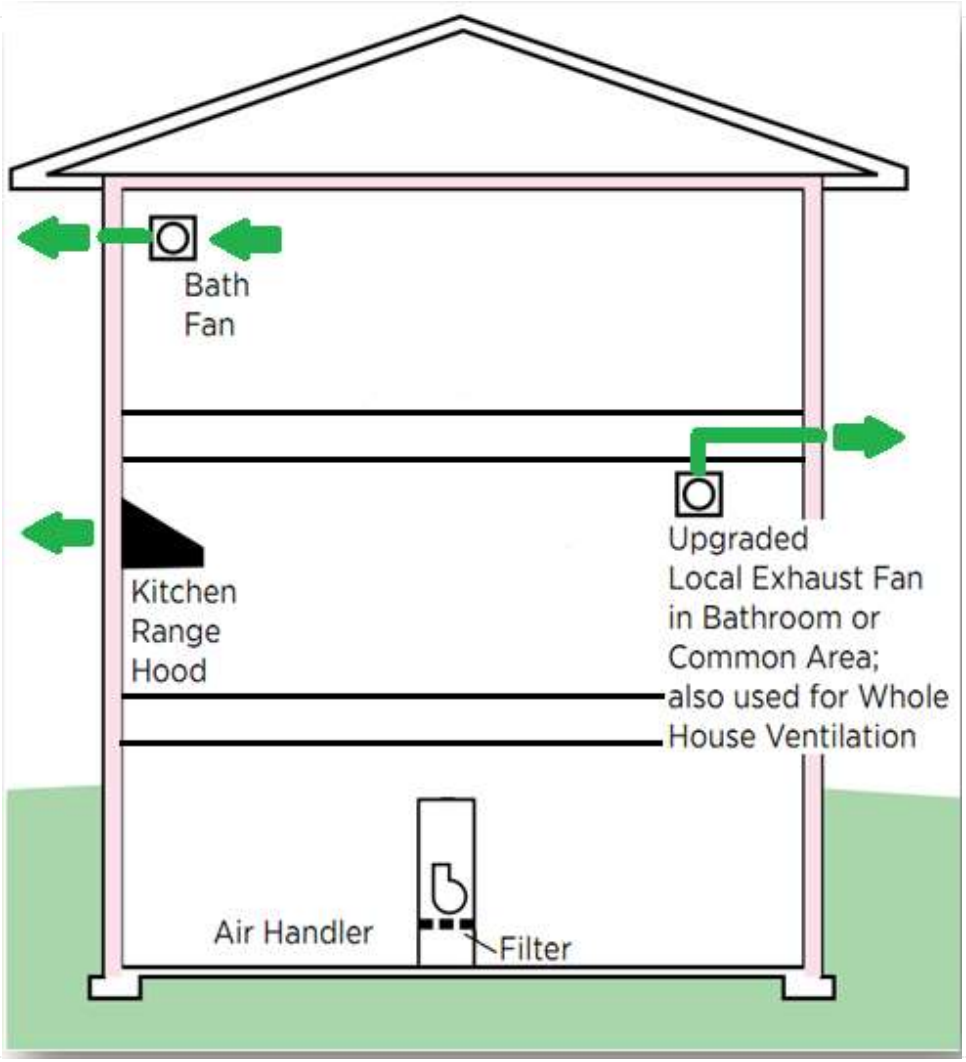
- Provide occupant information-
- Instructions on operation and maintenance
- Label controls

R403.5.6 Air Inlets and Exhausts (Mandatory)

- Inlets
  - 10 ft from contamination sources
  - Rodent screen
- Inlets or exhaust
  - Less than 7 feet from grade

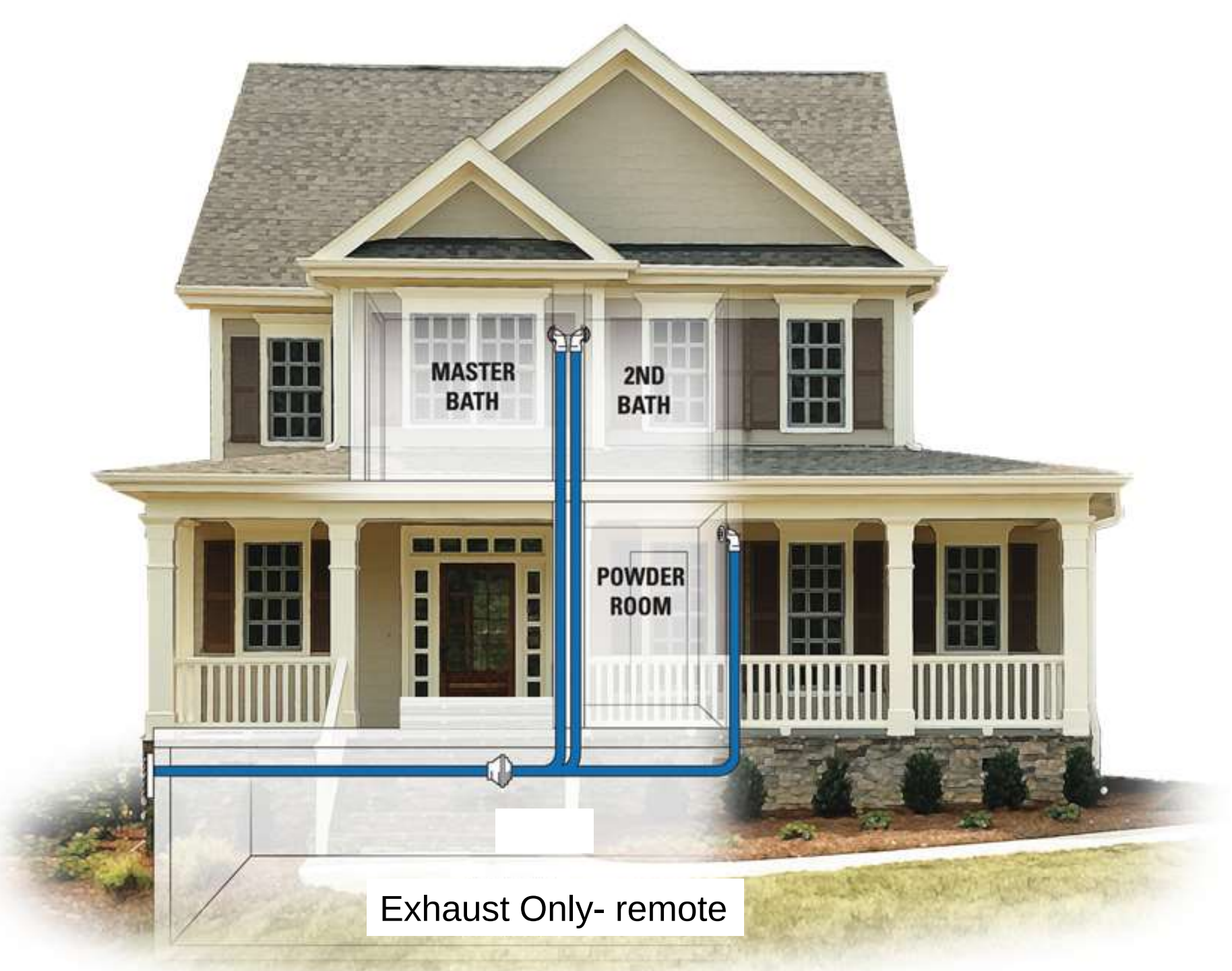
"MECH. VENT DIRECTLY BELOW KEEP CLEAR OF ALL OBSTRUCTIONS."

Exhaust-Only Ventilation



EPA – ENERGY STAR Homes

Quiet Bath Exhaust Fan & Controller



Exhaust Only- remote

Advantages: Exhaust-Only

- Easy to install
- Simple
- Inexpensive: $70 - $300
- Reduces moisture loading of the wall assemblies

Disadvantages: Exhaust-Only

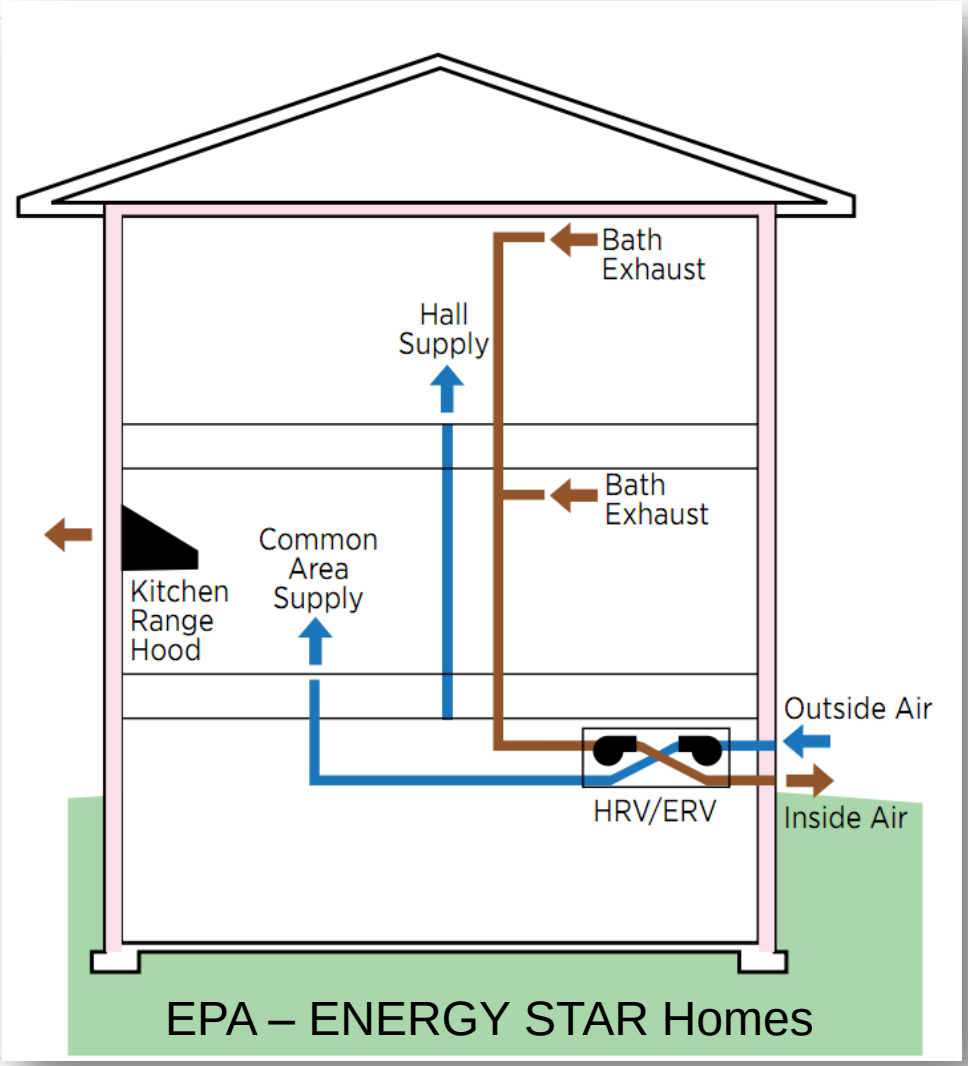
- Make-up air takes path of least resistance
- Distribution effectiveness in larger homes
- Occupant interference
- Removes heated or cooled air
- Brings in heat/cold/moisture

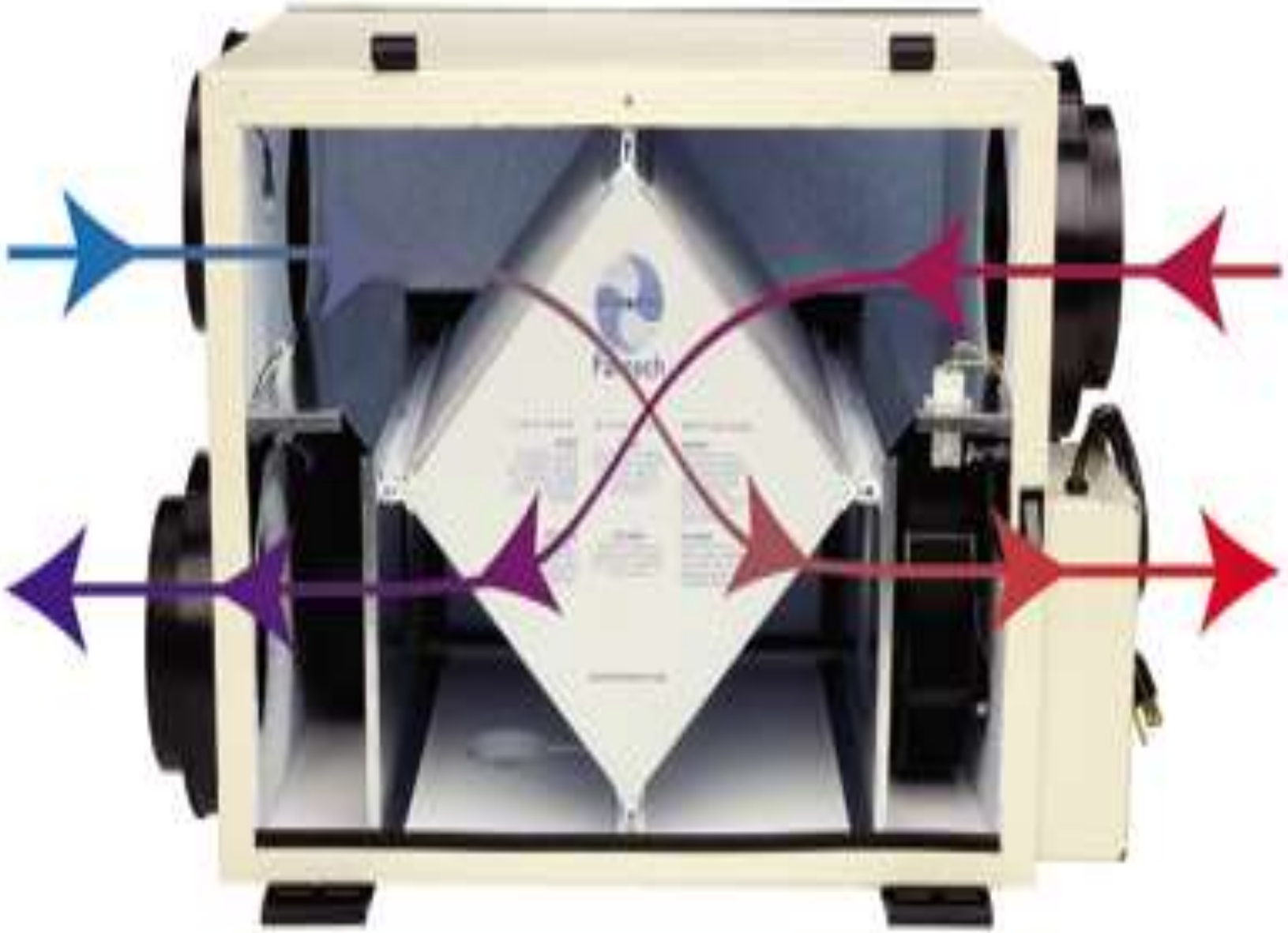
Improper Installation

Photo © Conservation Services Group

Photo © Conservation Services Group

Balanced Ventilation





Advantages: Balanced Ventilation

- No combustion impact
- Make-up air pathway is known
- Distribution is known
- Filtration
- No induced infiltration
- Recovers heat/cool/moisture
- Balanced pressure

Disadvantages: Balanced Ventilation

- Cost
  - Installation: $650 - $1,700+
- Complexity
- Potential for over ventilation
- Higher electric loads

R403.5.1 – Fan Efficacy (Mandatory)

Mechanical Ventilation System Fan Efficacy		
Fan Type/Location	**Flow Rate Min. (cfm)**	**Min. Efficacy (cfm/watt)**
Range hoods	Any	2.8
In-line fan	Any	2.8
Bathroom, utility room	10 – 90	1.4
Bathroom, utility room	90 +	2.8

Exception: **ECM** fans required if mechanical ventilation is integral to tested and listed HVAC equipment

Bathroom Fans

Make	CFM	Watt	CFM/Watt	Type	Model #
Panasonic Whisper Green	80	7	11.4	ceiling mounted	FV-08VKS3
Panasonic Whisper Value	100	36.4	2.7	ceiling mounted	FV-10VS1
Broan-Nutone	80	7.6	10.5	ceiling mounted	ZN80
Broan-Nutone	110	70.5	1.6	ceiling mounted	QTRN110
Fantech	120	18	6.7	Inline	FR125
Fantech	150	80	1.9	Inline	FR110

Heat/Energy Recovery Ventilators

Make	CFM	Watt	CFM/Watt	Sensible Recovery	Total Recovery	Type	Model #
Comfo Aire HRV	99	32	3.1	93%		HRV	CA 350 HRV
Renewaire	124	121	1.0	72%	46%	ERV	BR 130
Venmar	122	60	2.0	62%	52%	ERV	ASV ERV EKO 1.5
Fantech	84	40	2.1	54%		HRV	SH704
Lifebreath	117	67	1.7	78%		HRV	195ECM

R404.1 – Lighting Equipment (Mandatory)

- Minimum *75%* high-efficacy lamps in permanent fixtures
  - Exception – Low voltage lighting not required to use HE lamps

Performance Pathway

- Simulated energy performance analysis
  - Annual energy costs/source energy
- Allows for tradeoffs
  - Heating, cooling and DHW
- *Mandatory requirements still apply*

780 CMR - Eighth Edition

R405.6.2.1 MA Amendment

Approved Software Tools

Approved Alternative Energy Performance Methods

R405.6 Software Calculation Tools

- REScheck – V4.4 or later
  - www.energycodes.gov
- RESNET accredited software

REM/Rate™

EnergyGauge®
Energy Analysis & Rating Software

R405.6 Simulated Performance Alternative

2012 IECC Energy Cost Compliance

Property	Organization	HERS
Sample Any Road Grafton, MA	Conservation Services Group 1-508-836-9500 HERS Rater	Confirmed 12/17/2013 Rating No:58751 Rater ID:9901142
Weather:Gloucester, MA Sample sample REM .blg	Builder Bob builder	

Annual Energy Cost

$/yr

	2012 IECC	As Designed
Heating	1884	1812
Cooling	193	136
Water Heating	430	430
SubTotal - Used to Determine Compliance	2507	2378
Lights & Appliances	915	911
Photovoltaics	-0	-0
Service Charge	136	136
Total	3558	3425

Mandatory Requirements

Duct Insulation R-Value Check (per Section 405.2)		
Minimum Duct Insulation (Design must be equal or higher)	6.0	6.0
Window U-Factor Check (Section 402.5)		
Window U-Factor (Design must be equal or lower)	0.480	0.290
Home Infiltration (Section 402.4.1.2)		PASSES
Duct Leakage (Section 403.2.2)		PASSES
Mechanical Ventilation (Section 403.5)		PASSES

This home MEETS the annual energy cost requirements of Section 405 of the 2012 International Energy Conservation Code based on a climate zone of 5A. In fact, this home surpasses the requirements by 5.1%.

Name	HERS Rater	Signature	
Organization	Conservation Services Group	Date	6 May 2014

Mechanical Systems

Heating	Fuel-fired air distribution, 100.0 kBtuh, 96.0 AFUE.
Cooling	Air conditioner, 36.0 kBtuh, 13.0 SEER.
Water Heating	Conventional, Prop, 0.64 EF.
Window-to-Floor Area Ratio:	0.12
Blower door test	Htg: 2.63 Clg: 2.63 ACH50

This Home MEETS the annual energy cost requirements of Section 405 of the 2012 IECC based on climate Zone 5A. In fact this home surpasses the requirements by 5.1%

R405.7 Approved Alternative Energy Performance Methods

Approved software to demonstrate code compliance in addition to IECC R405

- RESNET approved software -HERS rating
  - HERS 65 or less – each dwelling unit w/o PV
  - ENERGY STAR Checklist verified by a HERS rater
- Passive House Institute (PHIUS) approved software
  - Specific space heat demand – 16KBtu/SF/YR
  - Certified Passive House Consultant
- Mandatory provisions also apply

R405.7.1 Compliance Documentation

Permit application

1. HERS Certificate – HERS 65 or less “based on plans”
   a) Listing energy features
2. Passive House Planning Package (PHPP) Specific Space Heat Demand - “based on plans”
   a) Listing compliance features

Certificate of Occupancy

1. HERS Certificate – HERS 65 or less “final or confirmed”
   a) Completed ENERGY STAR Thermal Enclosure Checklist
2. Passive House Planning Package (PHPP) Final Report
   a) Specific Space Heat Demand – =/>**16KBtu/SF/YR**
   b) Max design temps for load calcs – 72˚F/74˚F

R405.7.1 Compliance Documentation

Home Energy Rating Certificate

Any Road
Grafton, MA

5 Stars Plus
Confirmed
HERS Index: 56

Registry ID	915436931
Rating Number	58751
Certified Energy Rater	HERS Rater
Rating Date	12/17/2013
Rating Ordered For	Builder

General Information

Conditioned Area	3202 sq. ft.	House Type	Duplex, single unit
Conditioned Volume	28818 cubic ft.	Foundation	More than one type
Bedrooms	2		

Mechanical Systems Features

Heating:	Fuel-fired air distribution, Propane, 96.0 AFUE.
Cooling:	Air conditioner, Electric, 13.0 SEER.
Water Heating:	Conventional, Propane, 0.64 EF, 50.0 Gal.
Duct Leakage to Outside	98.73 CFM25.
Ventilation System	Exhaust Only: 55 cfm, 21.0 watts.
Programmable Thermostat	Heat=Yes; Cool=Yes

Building Shell Features

Ceiling Flat	R-40.0	Slab	R-10.0 Edge, R-0.0 Under
Sealed Attic	NA	Exposed Floor	R-30.0
Vaulted Ceiling	NA	Window Type	U-Value: 0.290, SHGC: 0.280
Above Grade Walls	R-21.0	Infiltration Rate	Htg: 2.63 Clg: 2.63 ACH50
Foundation Walls	R-0.0	Method	Blower door test

Lights and Appliance Features

Percent Interior Lighting	100.00	Range/Oven Fuel	Propane
Percent Garage Lighting	100.00	Clothes Dryer Fuel	Propane
Refrigerator (kWh/yr)	451.00	Clothes Dryer EF	2.67
Dishwasher Energy Factor	0.82	Ceiling Fan (cfm/Watt)	0.00

Estimated Annual Energy Cost

Use	MMBtu	Cost	Percent
Heating	62.1	$1548	50%
Cooling	2.2	$91	3%
Hot Water	17.6	$432	14%
Lights/Appliances	23.5	$911	29%
Photovoltaics	-0.0	$-0	-0%
Service Charges		$136	4%
Total	**105.4**	**$3118**	**100%**

Criteria

This home meets or exceeds the minimum criteria for the following:
EPA ENERGY STAR Version 2 Home

Senior Project Manager
Conservation Services Group
50 Washington St
Westborough, MA 01581
508-836-9500
Fax #

Certified Energy Rater: _____

The Home Energy Rating Standard Disclosure for this home is available from the rating provider.
REM/Rate - Residential Energy Analysis and Rating Software v14.4.1
This information does not constitute any warranty of energy cost or savings.

R405.7.1 Compliance Documentation

Passive House Planning Package (PHPP) Final Report

Energy Demands with Reference to the Treated Floor Area						
Treated Floor Area:	1842	ft^2				
	Applied:	Monthly Method			PH Certificate:	Fulfilled?
Specific Space Heat Demand:	**15.58**	**kBTU/(ft²yr)**		**4.75**	**kBTU/(ft²yr)**	**No**
Pressurization Test Result:	**0.60**	**ACH_{50}**		0.6	ACH_{50}	**Yes**
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):	**43.6**	**kBTU/(ft²yr)**		38.0	kBTU/(ft²yr)	**No**
Specific Primary Energy Demand (DHW, Heating and Auxiliary Electricity):	**29.7**	**kBTU/(ft²yr)**				
Specific Primary Energy Demand Energy Conservation by Solar Electricity:	**13.9**	**kBTU/(ft²yr)**				
Heating Load:	**10.03**	**BTU/(ft²hr)**				
Frequency of Overheating:		**%**	over	77.0	°F	
Specific Useful Cooling Energy Demand:	**1.80**	**kBTU/(ft²yr)**		4.75	kBTU/(ft²yr)	**Yes**
Cooling Load:	**4.65**	**BTU/(ft²hr)**				

US Green Building Council

Summary

- Performance pathway requirements
- Stringent air and duct leakage standards
- Mechanical ventilation required

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